Azimuthal di-hadron correlations in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV from STAR

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Abstract. We present the centrality dependence of the azimuthal angle correlation shapes between a trigger and associated charged hadrons in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV from the STAR experiment. The away-side structure is significantly modified in central collisions and is characterised in terms of a doubly-peaked yield. A minimum in the $<p_T>$ of hadrons opposite to the trigger particle is also investigated.

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Ultra-relativistic heavy-ion collisions were expected to create a weakly-interacting, deconfined state of quarks and gluons. Results from RHIC have shown that bulk particle production can be well modelled using hydrodynamics and the system may be strongly coupled. Di-hadron correlation studies [1, 2] have shown that hard partons from initial-state, back-to-back scatterings interact strongly with the system that is created, and can be used as a probe of the medium.

We present further di-hadron correlation results which are consistent with a picture in which hard-scattered partons, propagating faster than the speed of sound, deposit energy in the medium to set up conical flow.

We investigated di-hadron number correlations by choosing a trigger charged hadron in a particular p_T range and constructing a distribution of azimuthal angular differences between the trigger and associated charged hadrons in a specific p_T range. All hadrons were restricted to the range -1.0<η<1.0. The associated p_T window may overlap with that of the trigger hadrons. All presented results are corrected for the single particle efficiency and acceptance as well as the pair acceptance as a function of azimuthal difference.

The measured correlations contain a background of uncorrelated particles. The correlation of all particles with the reaction plane through elliptic flow, v_2 [3], gives rise to a $\cos 2\Delta\phi$ modulation of the background distribution. The background is removed by normalising the level of the v_2-modulated background to the minimum value of the raw correlation. The nominal v_2 value we subtract is the mean of two measurements [3, 4] using the reaction plane and four-particle cumulant techniques which give different results for v_2 due to different sensitivities to non-flow effects. The difference between the two limiting v_2 results is used as the estimate of the systematic uncertainty.

Figure 1 shows the background-subtracted azimuthal number correlations for various
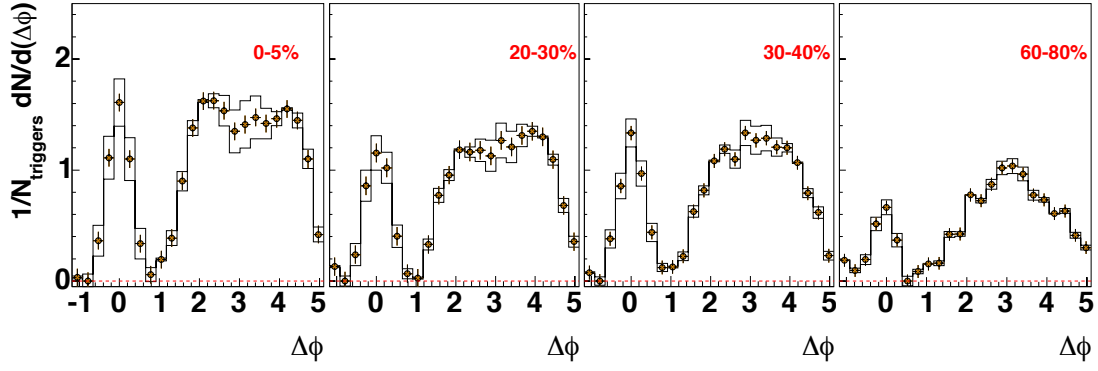
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[1] http://www.star.bnl.gov/central/collaboration/authors/authorList.php

FIGURE 1. Centrality dependence of number correlations for trigger hadrons with p_T between 4.0 and 6.0 GeV/c associated with hadrons with a p_T between 0.150 and 4.0 GeV/c. The panels show from top to bottom, left to right, decreasing centrality. Black lines show systematic uncertainty from the v_2 modulation of the background. The horizontal axis is offset for clarity.

centralities for trigger particles with p_T between 4.0 and 6.0 GeV/c and associated particles with p_T between 0.15 and 4.0 GeV/c. While for the most peripheral events (60-80%) two clear peaks are visible at $\Delta\phi = 0$ and π, the away-side structure is flatter and broader for more central events. The near-side yield also increases with increasing centrality and this may be related to a ridge-like yield in $\Delta\eta$ [5]. This behaviour is also observed in other trigger p_T ranges.

To characterise the away-side shape, we have fitted the distribution with several functional forms based on the idea that there is significant yield in a cone around π. This part of the yield is parameterised by a pair of Gaussian distributions symmetric about π. In addition some jet yield may still exist which is centered at π and we have characterised this using a $\cos\Delta\phi$ or Gaussian distribution.

Figure 2 shows half the separation between the Gaussian yields not centered at π as a function of associated hadron p_T. It can be seen in the figure that the separation is independent of the choice of central distribution shape and approximately independent of associated p_T, while if no additional yield is assumed to be present at $\Delta\phi = \pi$ (circle markers) the separation is slightly smaller and increasing with p_T. These results are not consistent with a picture in which the fragmentation of Cherenkov gluons is the dominant production mechanism for the yield away from $\Delta\phi = \pi$ [7].

Furthermore, we investigated the azimuthal dependence of associated hadron mean p_T, $<p_T>$. Figure 3 shows the $<p_T>$ as a function of azimuth for three different ranges of trigger p_T. The near-side $<p_T>$ values exhibit the expected hierarchy with increasing trigger p_T. The away-side inclusive $<p_T>$ distributions are similar for the two softer trigger ranges and slightly increased for the hardest triggers. For the correlated (background-subtracted), associated hadron $<p_T>$ we focus on the away-side in the right panel of Fig. 3. The results show a distribution depleted at π for the two softer trigger cases. For the case of trigger particles with p_T in the range 6.0 to 10.0 GeV/c the results are consistent with both depleted and flat distributions within statistical errors.

In summary, a significant broadening consistent with the appearance of secondary peaks has been observed in central Au+Au collisions as $\sqrt{s_{NN}} = 200$ GeV. The interpretation of this is still under investigation but the observed behaviour is consistent with
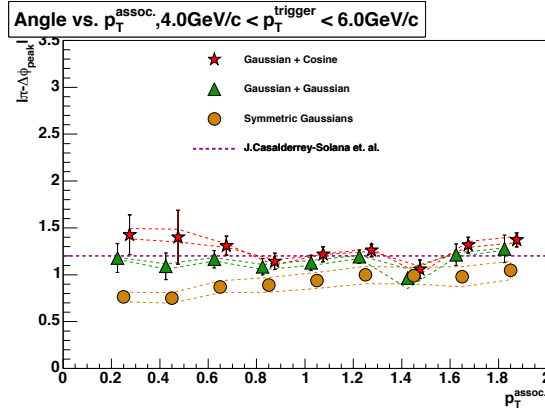
FIGURE 2. Distance of the symmetric Gaussian away from π as a function of associated particle p_T for trigger particles with p_Ts between 4.0 and 6.0 GeV/c in 0-5% central collisions. Horizontal line inspired by [6]. The dashed bands show the systematic uncertainty from v_2 determination.
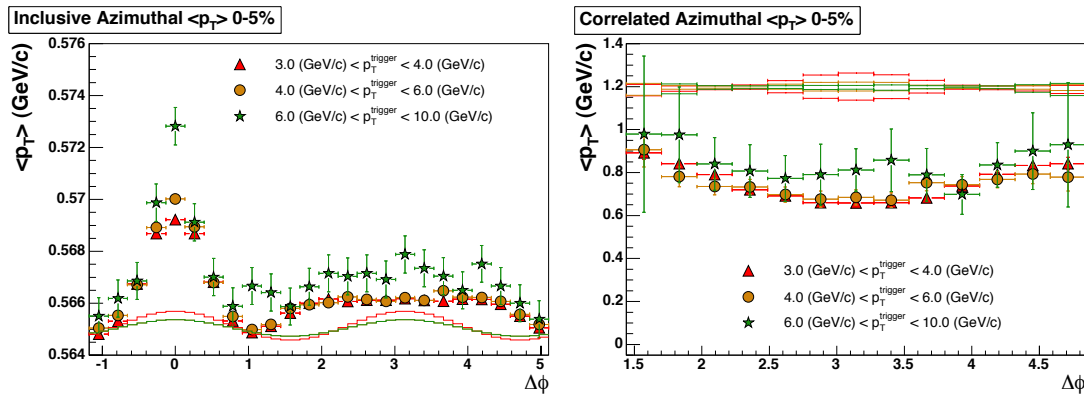

FIGURE 3. Inclusive, azimuthal $<p_T>$ (left panel) of associated hadrons in all events containing various classes of trigger particles. The lines show the variation in background for the different trigger ranges. In the right panel the away-side for the azimuthal $<p_T>$ of correlated particles. The $<p_T>$ is calculated for associated particles between 0.150 and 4.0 GeV/c. The lines show the systematic uncertainty in v_2.

conical flow built up in the medium. The angle of these secondary peaks relative to the center of the away-side distribution is approximately independent of associated hadron p_T. Similar structures are seen in associated hadron $<p_T>$ as a function of azimuthal angle with respect to the trigger particle.

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